Big Data and Computing Visions

www.bidacv.com

Big. Data. Comp. Vis. Vol. 4, No. 1 (2024) 31–48.

Paper Type: Original Article

Engineering Wired Network Performance Enhancement in a Route Redistributed Simulation Based Systems

Anniekan Essienubong Ikpe[1,*], Imoh Ime Ekanem[1]

[1] Akwa Ibom State Polytechnic, Ikot Osurua; aniekan.ikpe@akwaibompoly.edu.ng; imoh.ekanem@akwaibompoly.edu.ng.

Citation:

Received: 06 November 2023 *Revised: 11 Januray 2024* *Accepted: 23 Februray 2024*	Ikpe, A. E., & Ekanem, I. I. (2024). Engineering wired network performance enhancement in a route redistributed simulation based systems. *Big data and computing visions*, *4*(1), 31-48.

Abstract

As organizations keep expanding every day, there is a rapidly increasing need for communication networks to share routing information amongst the different routing protocols reliably. This study investigated the different ways network performance could be improved in a multiple protocol environment. As packets are routed from one routing domain to another, there are much packet losses, slow convergence time after link failures, instability and packets taking too many paths to reach its destinations due the different metrics used by the different routing protocols. In this study, the Open Shortest Path First (OSPF) and Enhanced Interior Gateway Routing Protocol (EIGRP) routing protocols were redistributed into one instance of routing. Packets were sent from EIGRP to OSPF domain and vice versa using the modified and default settings. The results showed that significant reduction in timer values reduced packet losses, increased network stability and also speedup convergence time for packets exiting the OSPF to EIGRP domains and vice versa. Shorter paths to destination was observed to ensure timely delivery of packets. The study provides valuable insights into enhancing the efficiency of numerous routing protocols operating as a unified entity. In order to effectively manage numerous protocols, network engineers and administrators must have a strong understanding of route redistribution procedure.

Keywords: Wired network, Route redistribution, Convergence time, Packet losses, Routing protocols.

1 | Introduction

The utilization of the internet is increasing on a daily basis, prompting providers of networks to employ novel techniques in order to fulfil the needs of traffic and improve current resources. The efficiency of network usage is determined by the routing of data packets, as each packet must follow a certain path to attain its intended route [1]. There is an increasing demand to spread applications over different networks using intermediary switching nodes and networks that have high capacity and good performance [2]. They provide

Corresponding Author: aniekan.ikpe@akwaibompoly.edu.ng
https://doi.org/10.22105/bdcv.2024.464144.1181

various services such as routing, video streaming, and voice apps to assist consumers. The transmission of internet data relies on the decentralized functioning of routing protocols. The protocols included are Border Gateway Protocol (BGP), Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), and Routing Information Protocol (RIP). Several Internet Service Providers (ISPs) and large corporate networks utilize several routing protocol instances concurrently [3]. The motivations for implementing route redistribution designs include the necessity to direct traffic based on various criteria, the aim to establish autonomy among different departments within a single firm, the need to filter route notifications, considerations of scalability, and economic factors.

Le et al. [4] conducted an analysis on the utilization of route redistribution in over 1600 networks, and discovered that 99.9% of these networks relied on it. The migration procedure from one routing protocol to another is a time-consuming operation that can potentially lead to system breakdowns. Therefore, redistribution is essential for establishing temporal connection between two or more route domains. Nigeria has a total of 89 banks with 3,382 branches, mainly located in metropolitan areas, as of June 2004. These banks exhibited structural and operational deficiencies, including a poor financial base, bankruptcy, and liquidity issues. Against this background, former Governor of the Central Bank of Nigeria, Professor Chukwuma Soludo, unveiled a comprehensive 13-point reform agenda for the banking industry [5].

Using a single routing protocol in an inter-network environment is recommended for the sake of simplicity and ease of maintenance. Regrettably, achieving this is not consistently feasible, resulting in the prevalence of multi-protocol settings [6]. Redistribution refers to the utilization of a routing protocol to propagate routes acquired from different routing protocol, such as static routes or directly related routes. While it is preferable to have a single routing protocol for the entire IP internetwork, it is typical to have multi-protocol routing for many reasons, such as corporate mergers, several departments with different network managers, and multi-vendor settings. Router makers and network operators have recognized the hazards associated with route redistribution. However, there is now no universal directive for properly configuring route redistribution. Current solutions are sometimes built on a case-by-case basis for unique scenarios, but they generally fail to meet the network design objectives [7].

The number of routing protocol cases may increase when new technologies such as wireless networks, ad-hoc networks, vehicular ad-hoc networks, and sensor networks develop. Each of these technologies has unique properties and hence requires different routing protocols [8]. Operators require a secure method to link different routing instances in this particular situation. When dealing with a network architecture that includes various branches and numerous redistribution points, network engineers must prioritize efficiency as a crucial component.

Le et al [9] conducted an analysis on the utilization of route redistribution in over 1600 networks, and discovered that 99.9% of these networks relied on it. The transition from one routing protocol to another is a time-consuming procedure that can potentially lead to system breakdowns. Therefore, redistribution is essential for establishing temporal connectedness between two or more route domains. In a setting where route redistribution occurs, it is typical for sub-optimal routing to be misconfigured, resulting in route oscillations and persistent routing loops [10]. When numerous protocols are being run, each routing protocol employs distinct metrics to ascertain the most optimum route to a destination. Due to these dissimilarities, routers may forward packets via a suboptimal path. The instability and failures of links result in network instability, leading to a substantial increase in network convergence time [11].

The rapid convergence of connections after failure is crucial. Packet loss has a detrimental impact on the overall efficiency of the network. Elevated levels of packet loss can result in an increase in the number of packets that need to be retransmitted, which can have a detrimental effect on the overall performance of the network [12]. Excessive packet losses significantly decrease the dependability of communication systems, hence posing a network security risk. Summary of relevant literature engineering wired network performance enhancement in a route redistributed simulation based systems is presented in *Table 1*. The main focus of this research is the integration of two routing protocols, namely OSPF and EIGRP. The task will be executed via

wired networks within a simulated environment. This study specifically examines the occurrence of packet losses during link failures, the time it takes to rediscover links, and the usage of suboptimal routing. There has been limited research on the performance of these combined networks after implementing route redistribution. This research will offer network engineers valuable insights to enhance the effective management of their redistributed networks, namely in areas like as missed packets, convergence time, and inefficient routing. This research might be utilized in tertiary institutions to enhance the education of students pursuing careers in networking engineering, particularly in the field of network computing.

Table 1. Summary of relevant literature.

Ref.	Title	Result	Limitations/Gaps
[13]	Performance comparison of two dynamic routing protocols: RIP and OSPF.	OSPF had better performance in terms of throughput and delay than RIP.	There were no route redistribution. No comparison between packet loss and convergence time.
[14]	Evaluation of OSPF and EIGRP routing protocols for IPv6.	EIGRP protocol has many advantages over OSPF but cost is a challenge.	IPv4 was not used. There was no route redistribution amongst routing protocols.
[15]	Performance analysis of RIP and OSPF in network using OPNET.	Convergence time of OSPF single area as greater than OSPF multi area. OSPF converged faster than RIP.	There were no relationships between packet loss and convergence time.
[16]	Performance analysis of OSPF and EIGRP routing protocols for greener internetworking.	EIGRP was better than OSPF for real time, and lesser CPU resources were sed.	The performance analysis was done for only default timers and there was no route redistribution.
[17]	Simulation based comparative study of RIP, OSPF and EIGRP.	They concluded that EIGRP had higher throughputs and less packet losses than other protocols.	They used only default timers of routing protocols to make their submission.
[18]	A study on the impact of multiple failures on OSPF convergence.	Decrease in timer value reduced convergence delay but smaller timer amplified network instability.	They only used one routing protocol, and their concluding thoughts were contradictory.
[19]	Comparative performance analysis of link recovery between EIGRP and OSPF protocols based on simulation.	The throughputs of EIGRP were higher than OSPF due to congestion in the link.	There was no relationship between link recovery and packet loss.
[20]	Comparative study of EIGRP and RIP using cisco packet tracer.	EIGRP had better convergence and elay time than RIP.	They used only default timers to arrive at their conclusion.
[21]	Performance evaluation of real time applications for RIP, OSPF and EIGRP for flapping links, using OPNET modeler.	The convergence time of RIP was better than OSPF. OSPF had the highest umber of dropped packets.	There was no Redistribution amongst the three routing protocols. The modified timers were not used.
[22]	Performance optimization of OSPF protocol in IPv6 networks.	Large values of OSPF timers caused slower convergence and smaller values caused faster convergence.	They did not use IPv4, and only one routing protocol was used.
[1]	OSPF vs EIGRP: a comparative analysis of PU utilization using opnet.	EIGRP acquired same information again and again, thereby, wasting the CPU resources.	There were no route redistribution.

2 | Materials and Methods

This chapter deals with the network designs and simulation of OSPF via EIGRP. This design will be done using Graphical Network Simulator (GNS-3), first for a simple EIGRP network topology and then for OSPF networks. Mutual route redistribution of OSPF into EIGRP and EIGRP into OSPF would be done. The various timers and other parameters will be varied to ascertain their effects.

2.1|Network Design and Requirements

The devices required for the network layout includes 4 Routers (c3745), 4 Ethernet Switches, 8 Virtual PCs, 8 Serial Links (cables) and 12 Fast Ethernet cables (CAT 5E). Ideally, it is the ISP that provides the clocking for the networks. The clocking defines the speed, and sets the line to operate at that speed. In a lab environment, you need to set one end of the cable as Data Communication Equipment (DCE) and hence set the clock rate at that time. In this lab, the clock rate used is 64000b/s and the bandwidth is 64Kb/s. This bandwidth is used by the routing protocols (OSPF and EIGRP) to calculate the cheapest route to a destination. The execution flow process is illustrated in *Fig. 1*.

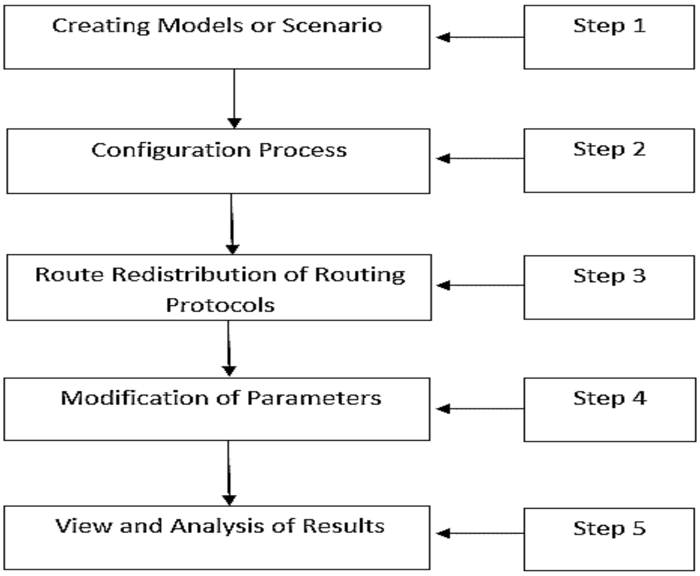


Fig. 1. Execution flow process.

2.2|Network Emulator

In this research work, i used GNS3 2.1.3 and Virtual Machine (GNS3 VM) in creating the network model. The GNS3 is an open source network software emulator that helps simulate complex networks as close as possible to the real network. The GNS3 uses many emulators to run the same operating system as the real networks. These include:

I. Dynamips- CISCO IOS emulator.

II. Virtual box which runs desktop and server operating systems as well as juniper.

III. Qemu is a generic open source machine emulator.

Step 1. Creating of network model

The first step in the process was developing the network topology model which is presented in *Fig. 2*. The network profile in *Fig. 2* has five departments, ICT, works, bursary, engineering and Administration. On the one hand, the ICT and Works departments are running EIGRP with an Autonomous System (AS) number 100 (AS 100). On the other hand, Bursary, Engineering and Administration departments are running OSPF protocol with area 0. The router summary interface is presented in *Table 2*.

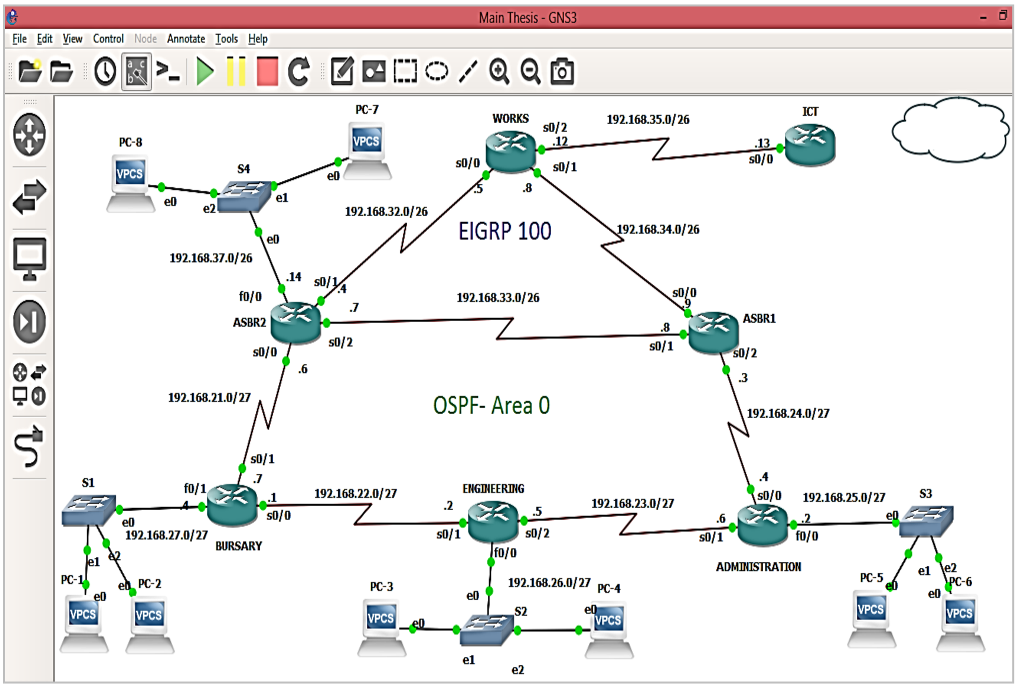


Fig. 2. Network topology model.

Table 2. Router summary interface.

Routers	Loopback Address	IP Address of Serial Link
ICT	L25---192.168.53.1/25	S0/0---192.168.35.13/26
Director	L26---192.168.50.1/25	
Deputy director	L27---192.168.51.1/25	
Cloud engineer 1	L28---192.168.52.1/25	
System analyst 1		
Works		
Director	L21---192.168.15.1/24	S0/0--192.168.32.5/26
Deputy director	L22---192.168.60.1/30	S0/1--192.168.34.8/26
Chief surveyor	L23---192.168.61.1/30	S0/2--192.168.35.12/26
Chief architect	L24---192.168.62.1/30	
ASBR1	-	S0/0--192.168.34.9/26
		S0/1--192.168.33.8/26
		S0/2--192.168.24.3/27
ASBR2	-	S0/0--192.168.21.6/27
		S0/1--192.168.32.4/26
		S0/2--192.168.33.7/26
Bursary		
Bursar	L29---192.168.70.1/28	S0/0--192.168.22.1/27
Chief accountant	L30---192.168.71.1/28	S0/1--192.168.21.7/27
Chief auditor	L31---192.168.72.1/28	
Chief cashier	L32---192.168.73.1/28	
Engineering		
Civil/structural	L33---192.168.80.1/29	S0/1--192.168.22.7/27
Electrical	L34---192.168.81.1/29	S0/2--192.168.23.5/27
Mechanical	L35---192.168.82.1/29	
Petroleum	L36---192.168.83.1/29	
Admin		
MD/CEO	L20---192.168.11.1/24	S0/0--192.168.24.4/27
Deputy MD	L19---192.168.40.1/27	S0/1--192.168.23.6/27
Secretary	L18---192.168.41.1/27	
Chief security	L17---192.18.42.1/27	
Control unit	L16---192.168.43.1/27	

Step 2. Configuration process.

Fig. 3 displays the interface that are directly linked and the loopback addresses on the device named WORKS. This information is obtained by using the command "show IP interface brief". The interfaces are associated with the IP addresses that are inputted in the configuration mode of the router. The indicator suggests that the status is active and the protocol is functioning. The "status up" indicates that there is proper physical connectivity and that it is operating at the physical layer. The "protocol up" verifies the consistency of keep-alive signals and ensures that the clock rate is properly configured on both ends. The IP address 192.168.32.5 was allocated to the serial interface 0/0, and the physical connection is active. The line protocol is functioning well, indicating that the clocking was configured appropriately.

```
WORKS
WORKS#sh ip int brie
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        unassigned      YES NVRAM  administratively down down
Serial0/0              192.168.32.5    YES NVRAM  up                    up
FastEthernet0/1        unassigned      YES NVRAM  administratively down down
Serial0/1              192.168.34.8    YES NVRAM  up                    up
Serial0/2              192.168.35.12   YES NVRAM  up                    up
Serial0/3              unassigned      YES NVRAM  administratively down down
Serial0/4              unassigned      YES NVRAM  administratively down down
Serial0/5              unassigned      YES NVRAM  administratively down down
Loopback21             192.168.15.1    YES NVRAM  up                    up
Loopback22             192.168.60.1    YES NVRAM  up                    up
Loopback23             192.168.61.1    YES NVRAM  up                    up
Loopback24             192.168.62.1    YES NVRAM  up                    up
```

Fig. 3. Interface of WORKS router.

```
ICT
     192.168.61.0/30 is subnetted, 1 subnets
D       192.168.61.0 [90/40640000] via 192.168.35.12, 00:06:31, Serial0/0
D    192.168.15.0/24 [90/40640000] via 192.168.35.12, 00:06:31, Serial0/0
     192.168.60.0/30 is subnetted, 1 subnets
D       192.168.60.0 [90/40640000] via 192.168.35.12, 00:06:31, Serial0/0
     192.168.53.0/25 is subnetted, 1 subnets
C       192.168.53.0 is directly connected, Loopback25
     192.168.52.0/25 is subnetted, 1 subnets
C       192.168.52.0 is directly connected, Loopback28
     192.168.37.0/26 is subnetted, 1 subnets
D       192.168.37.0 [90/41049600] via 192.168.35.12, 00:06:32, Serial0/0
     192.168.34.0/26 is subnetted, 1 subnets
D       192.168.34.0 [90/41024000] via 192.168.35.12, 00:06:40, Serial0/0
     192.168.51.0/25 is subnetted, 1 subnets
C       192.168.51.0 is directly connected, Loopback27
     192.168.50.0/25 is subnetted, 1 subnets
C       192.168.50.0 is directly connected, Loopback26
     192.168.35.0/26 is subnetted, 1 subnets
C       192.168.35.0 is directly connected, Serial0/0
     192.168.32.0/26 is subnetted, 1 subnets
D       192.168.32.0 [90/41024000] via 192.168.35.12, 00:06:46, Serial0/0
     192.168.33.0/26 is subnetted, 1 subnets
D       192.168.33.0 [90/41536000] via 192.168.35.12, 00:06:46, Serial0/0
ICT#
```

Fig. 4. Routing interface of ICT.

Fig. 4 displays the routing interface of ICT that was configured via EIGRP. EIGRP disseminates its whole routing table to neighbouring routers that have established adjacency via the hello messages. Prior to establishing any neighbouring connection, it is necessary for the AS number to be same. The presence of the letter "D" in the routing table indicates that it is a route using the EIGRP. The WORKS and ICT departments belong to the EIGRP domain. The routing table indicates that the networks 192.168.15.1, 192.168.60.0, and 192.168.61.0 are loopback IP associated with the WORKS department. The networks 192.168.37.0, 192.168.34.0, and 192.168.32.0 are used as serial and Ethernet linkages to connect the WORKS department, ASBR1, and ASBR2. The ICT router identified these networks within the EIGRP domain through the utilization of the gateway, which is the network 192.168.35.12. The letter "C" in the routing table signifies networks that are directly connected. *Fig. 4* indicates that the EIGRP configuration in the model was done correctly.

Fig. 5 represents the routing interface specifically linked with the engineering department. The Bursary, Engineering, and Administration are part of the OSPF domain. The S0/2 interface of ASBR1 and the S0/1 interface of ASBR2 are included in the OSPF domain. The neighboring relationship was created by the exchange of greeting texts. The letter "O" indicates that it is an OSPF route, whereas the letter "C" indicates that it is a directly connected interface. The Engineering router detected the networks 192.168.24.0, 192.168.40.1, 192.168.11.1, and 192.168.41.1 within the EIGRP domain through the gateway 192.168.23.6. The loopback addresses of Bursary and Administration were also acquired via the adjacency connection. Based on the information provided in *Fig. 4* and *Fig.*5, it can be observed that the routes inside the OSPF domain (Engineering, Bursary, and Administration) have not acquired any routes from the EIGRP domain (Works and ICT), and vice versa.

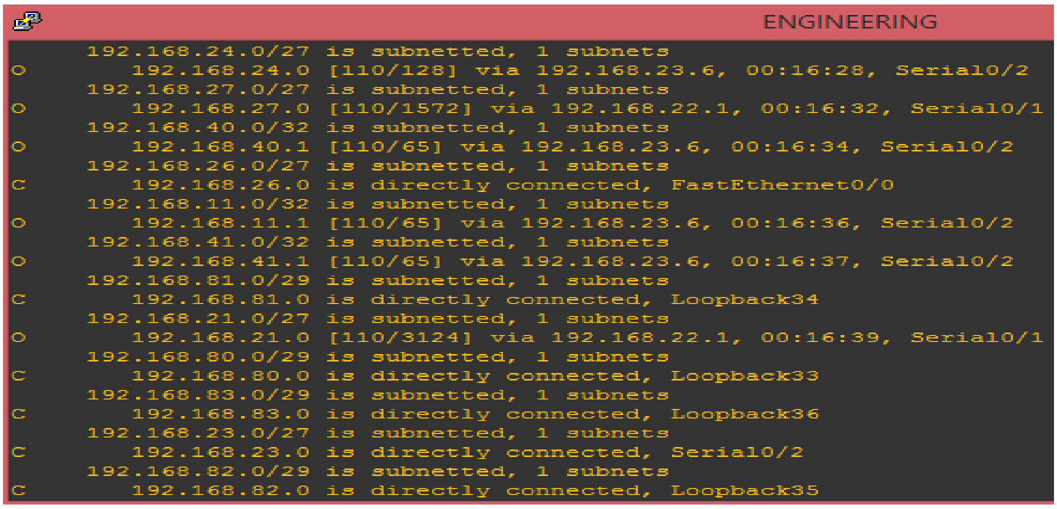

```
ENGINEERING
     192.168.24.0/27 is subnetted, 1 subnets
O       192.168.24.0 [110/128] via 192.168.23.6, 00:16:28, Serial0/2
     192.168.27.0/27 is subnetted, 1 subnets
O       192.168.27.0 [110/1572] via 192.168.22.1, 00:16:32, Serial0/1
     192.168.40.0/32 is subnetted, 1 subnets
O       192.168.40.1 [110/65] via 192.168.23.6, 00:16:34, Serial0/2
     192.168.26.0/27 is subnetted, 1 subnets
C       192.168.26.0 is directly connected, FastEthernet0/0
     192.168.11.0/32 is subnetted, 1 subnets
O       192.168.11.1 [110/65] via 192.168.23.6, 00:16:36, Serial0/2
     192.168.41.0/32 is subnetted, 1 subnets
O       192.168.41.1 [110/65] via 192.168.23.6, 00:16:37, Serial0/2
     192.168.81.0/29 is subnetted, 1 subnets
C       192.168.81.0 is directly connected, Loopback34
     192.168.21.0/27 is subnetted, 1 subnets
O       192.168.21.0 [110/3124] via 192.168.22.1, 00:16:39, Serial0/1
     192.168.80.0/29 is subnetted, 1 subnets
C       192.168.80.0 is directly connected, Loopback33
     192.168.83.0/29 is subnetted, 1 subnets
C       192.168.83.0 is directly connected, Loopback36
     192.168.23.0/27 is subnetted, 1 subnets
C       192.168.23.0 is directly connected, Serial0/2
     192.168.82.0/29 is subnetted, 1 subnets
C       192.168.82.0 is directly connected, Loopback35
```

Fig. 5. Routing interface of engineering.

Step 3. Redistribution of routing protocol.

ASBR1 and ASBR2 serve as intermediary routers that connect the OSPF and EIGRP networks in the network design. ASBR1 and ASBR2 are connected to interfaces in both the OSPF and EIGRP networks. Before route redistribution, EIGRP networks were unable to get information about routes in the OSPF domain, and vice versa. The ICT and Works routers lacked the routes to Engineering, Bursary, and Administration in their routing tables. *Fig. 4* illustrates this. The OSPF routes were inserted into the EIGRP domain, and the EIGRP routes were inserted into the OSPF domain using ASBR1 and ASBR2.

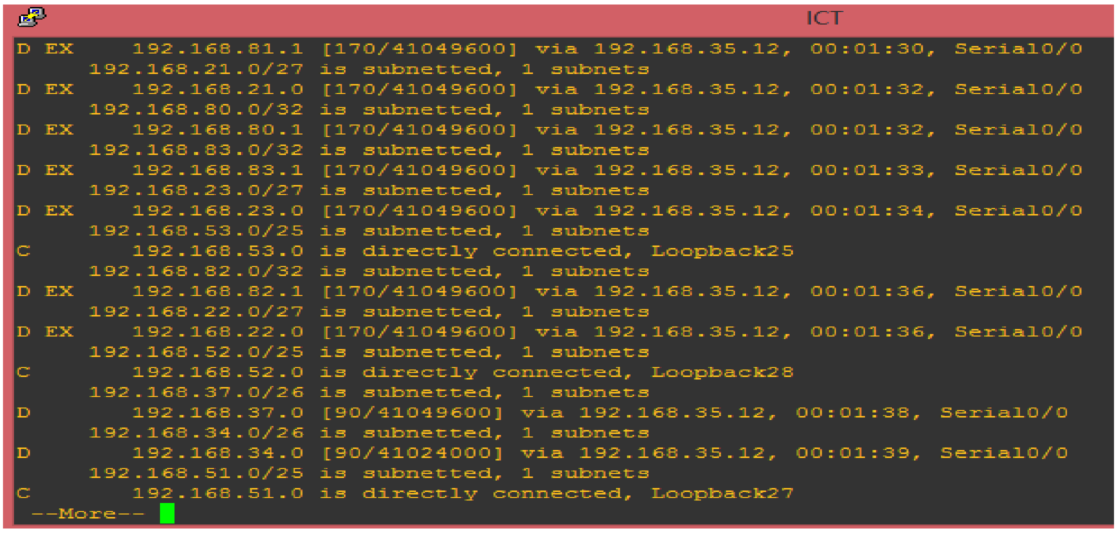

```
ICT
D EX    192.168.81.1 [170/41049600] via 192.168.35.12, 00:01:30, Serial0/0
     192.168.21.0/27 is subnetted, 1 subnets
D EX    192.168.21.0 [170/41049600] via 192.168.35.12, 00:01:32, Serial0/0
     192.168.80.0/32 is subnetted, 1 subnets
D EX    192.168.80.1 [170/41049600] via 192.168.35.12, 00:01:32, Serial0/0
     192.168.83.0/32 is subnetted, 1 subnets
D EX    192.168.83.1 [170/41049600] via 192.168.35.12, 00:01:33, Serial0/0
     192.168.23.0/27 is subnetted, 1 subnets
D EX    192.168.23.0 [170/41049600] via 192.168.35.12, 00:01:34, Serial0/0
     192.168.53.0/25 is subnetted, 1 subnets
C       192.168.53.0 is directly connected, Loopback25
     192.168.82.0/32 is subnetted, 1 subnets
D EX    192.168.82.1 [170/41049600] via 192.168.35.12, 00:01:36, Serial0/0
     192.168.22.0/27 is subnetted, 1 subnets
D EX    192.168.22.0 [170/41049600] via 192.168.35.12, 00:01:36, Serial0/0
     192.168.52.0/25 is subnetted, 1 subnets
C       192.168.52.0 is directly connected, Loopback28
     192.168.37.0/26 is subnetted, 1 subnets
D       192.168.37.0 [90/41049600] via 192.168.35.12, 00:01:38, Serial0/0
     192.168.34.0/26 is subnetted, 1 subnets
D       192.168.34.0 [90/41024000] via 192.168.35.12, 00:01:39, Serial0/0
     192.168.51.0/25 is subnetted, 1 subnets
C       192.168.51.0 is directly connected, Loopback27
 --More--
```

Fig. 6. Routing interface of ICT after route redistribution.

Fig. 7. displays the routing interface of the Administration network after OSPF and EIGRP routes were added to the ASBR1 and ASBR2 routers. The acronym "O E2" denotes an OSPF external type two route, which indicates that it is a route outside of the OSPF domain. The loopback addresses of the ICT department, namely 192.168.53.0, 192.168.52.0, and 192.168.51, were acquired through the 192.168.24.3 source. The IP addresses 192.168.35.0 and 192.168.34.0 represent serial connections inside the EIGRP domain. The configuration of route redistribution has been correctly implemented based on the displayed output. The OSPF domain has visibility of routes within the EIGRP domain, and conversely, the EIGRP domain has visibility of routes within the OSPF domain.

```
ADMINISTRATION
      192.168.53.0/25 is subnetted, 1 subnets
O E2     192.168.53.0 [110/20] via 192.168.24.3, 00:06:48, Serial0/0
      192.168.82.0/32 is subnetted, 1 subnets
O        192.168.82.1 [110/1563] via 192.168.23.5, 00:34:29, Serial0/1
      192.168.22.0/27 is subnetted, 1 subnets
O        192.168.22.0 [110/3124] via 192.168.23.5, 00:34:29, Serial0/1
      192.168.52.0/25 is subnetted, 1 subnets
O E2     192.168.52.0 [110/20] via 192.168.24.3, 00:06:48, Serial0/0
      192.168.37.0/26 is subnetted, 1 subnets
O E2     192.168.37.0 [110/20] via 192.168.24.3, 00:34:29, Serial0/0
      192.168.34.0/26 is subnetted, 1 subnets
O E2     192.168.34.0 [110/20] via 192.168.24.3, 00:34:29, Serial0/0
      192.168.51.0/25 is subnetted, 1 subnets
O E2     192.168.51.0 [110/20] via 192.168.24.3, 00:06:50, Serial0/0
      192.168.50.0/25 is subnetted, 1 subnets
O E2     192.168.50.0 [110/20] via 192.168.24.3, 00:06:50, Serial0/0
      192.168.35.0/26 is subnetted, 1 subnets
O E2     192.168.35.0 [110/20] via 192.168.24.3, 00:34:30, Serial0/0
      192.168.32.0/26 is subnetted, 1 subnets
O E2     192.168.32.0 [110/20] via 192.168.24.3, 00:35:00, Serial0/0
      192.168.70.0/32 is subnetted, 1 subnets
O        192.168.70.1 [110/3125] via 192.168.23.5, 00:35:15, Serial0/1
      192.168.33.0/26 is subnetted, 1 subnets
 --More--
```

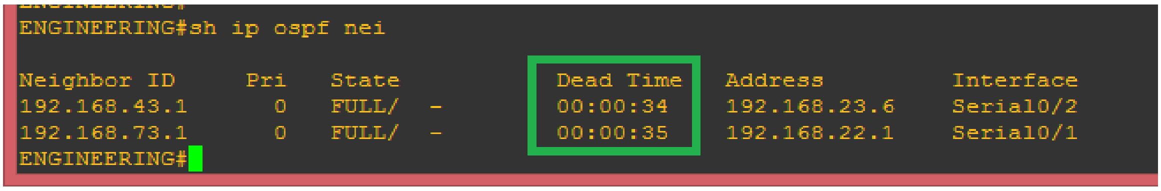
Fig. 7. Routing interface of Administration after route redistribution.

Step 4. Modification of parameters.

This step involved the OSPF parameters modification. The OSPF has a default configuration that is implemented by manufacturers. From *Fig. 8*, the Hello Timer for OSPF is set to 10 seconds, the Dead Timer is set to 40 seconds, the Wait Timer is set to 40 seconds, and the Retransmit duration is set to 5 seconds. The term "Wait 40" refers to the specific time interval that triggers the interface to depart the waiting period and designate a Designated Router (DR). The "Retransmit 5" parameter indicates the duration, measured in seconds which the routing device will wait to receive acknowledgement before retransmitting the Link State Advertisement (LSA) to a neighbouring interface. *Fig. 9* illustrates the distinct Dead times for the networks 192.168.43.1 and 192.168.73.1. The timestamp 00:00:34 indicates that the network with IP address 192.168.43.1 has a remaining duration of 6 seconds prior to being considered inactive (34 + 6 = 40).

```
ENGINEERING
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.26.3/27, Area 0
  Process ID 1, Router ID 192.168.83.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.83.1, Interface address 192.168.26.3
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:06
  Supports Link-local Signaling (LLS)
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial0/2 is up, line protocol is up
  Internet Address 192.168.23.5/27, Area 0
  Process ID 1, Router ID 192.168.83.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:04
 --More--
```

Fig. 8. Default timers of the OSPF.

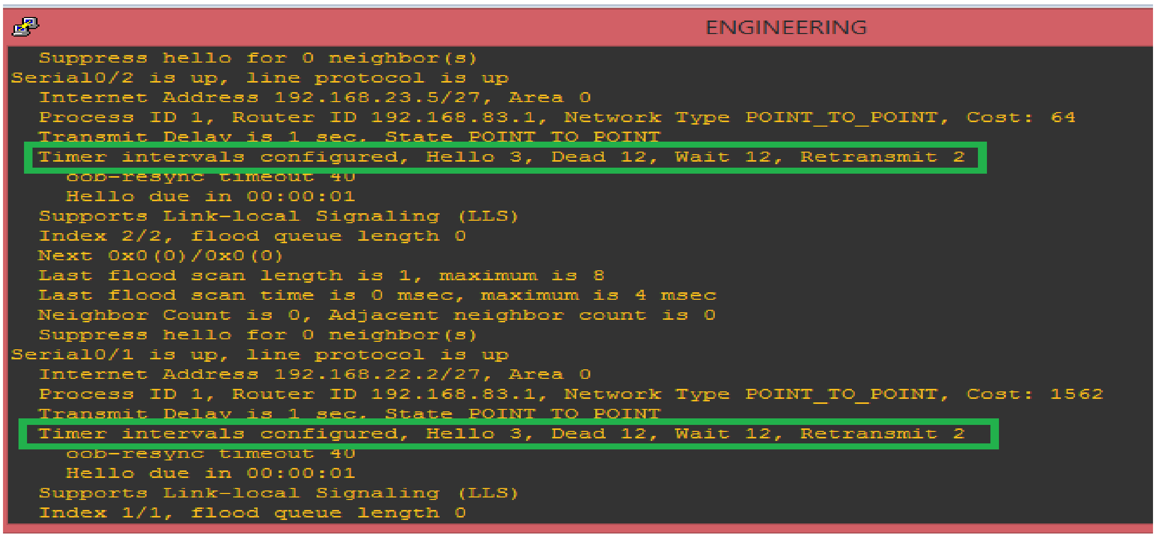


```
ENGINEERING#sh ip ospf nei

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.43.1      0   FULL/  -        00:00:34    192.168.23.6    Serial0/2
192.168.73.1      0   FULL/  -        00:00:35    192.168.22.1    Serial0/1
ENGINEERING#
```

Fig. 9. Inactive timers of the OSPF neighbours.

The default OSPF configuration has been modified on the Serial0/1, Serial0/2, and FastEthernet0/0 interfaces of the Engineering router shown in *Fig. 10*. The OSPF Hello packet is sent by the router every three seconds, and a neighbour is considered inactive if no communication is received within twelve seconds. The duration of the inactive period is consistently three times the length of the Hello interval. The Wait time is equivalent to the Dead time, and the Retransmission time was adjusted to two seconds.

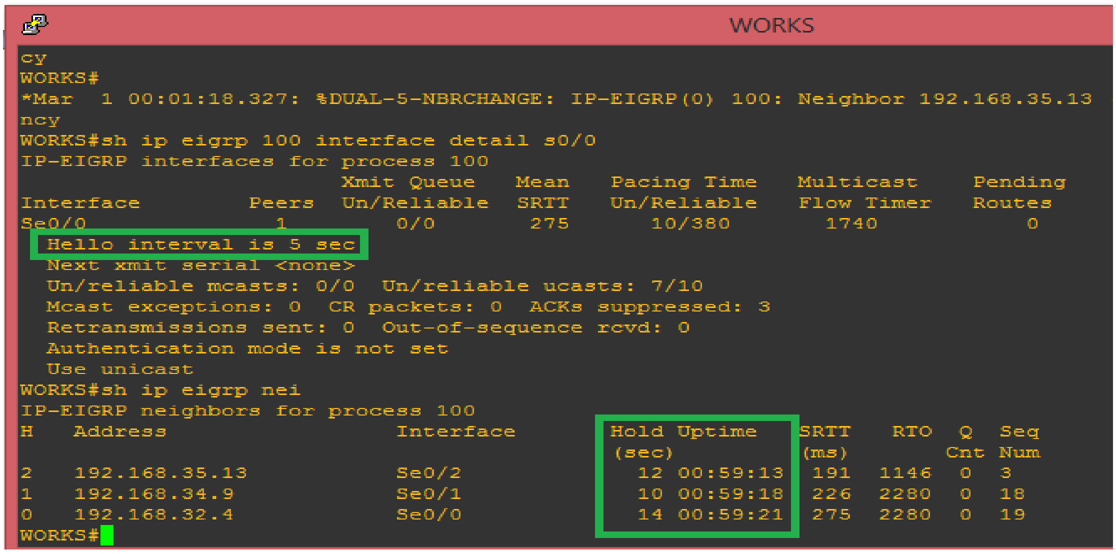


```
ENGINEERING
  Suppress hello for 0 neighbor(s)
Serial0/2 is up, line protocol is up
  Internet Address 192.168.23.5/27, Area 0
  Process ID 1, Router ID 192.168.83.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 3, Dead 12, Wait 12, Retransmit 2
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 8
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial0/1 is up, line protocol is up
  Internet Address 192.168.22.2/27, Area 0
  Process ID 1, Router ID 192.168.83.1, Network Type POINT_TO_POINT, Cost: 1562
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 3, Dead 12, Wait 12, Retransmit 2
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
```

Fig. 10. Modified OSPF timers.

2.3 | Modification of EIGRP Parameters

The default EIGRP Timers profile is presented in *Fig. 11*. Cisco IOS runs the EIGRP with default timing settings. This protocol is exclusive to Cisco. The Hello interval is set to five seconds, which is the frequency at which an EIGRP router transmits Hello packets to its neighbouring router.



```
WORKS
cy
WORKS#
*Mar  1 00:01:18.327: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor 192.168.35.13
ncy
WORKS#sh ip eigrp 100 interface detail s0/0
IP-EIGRP interfaces for process 100
                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Se0/0              1        0/0       275       10/380        1740           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/0  Un/reliable ucasts: 7/10
  Mcast exceptions: 0  CR packets: 0  ACKs suppressed: 3
  Retransmissions sent: 0  Out-of-sequence rcvd: 0
  Authentication mode is not set
  Use unicast
WORKS#sh ip eigrp nei
IP-EIGRP neighbors for process 100
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
2   192.168.35.13           Se0/2             12 00:59:13  191  1146  0  3
1   192.168.34.9            Se0/1             10 00:59:18  226  2280  0  18
0   192.168.32.4            Se0/0             14 00:59:21  275  2280  0  19
WORKS#
```

Fig. 11. Default EIGRP timers profile.

The Hold Uptime is consistently three times the Hello interval, which is equivalent to fifteen seconds. The Hold Uptime refers to the duration during which a router that is communicating via the EIGRP protocol considers a neighbouring router to be operational, even if it does not receive any Hello packets. As shown in *Fig. 10*, the S0/0 interface has a Hello interval of 5. The EIGRP neighbours, with IP addresses 192.168.35.13, 192.168.34.9, and 192.168.32.4, have Hold Uptime values of 12, 10, and 14 seconds, respectively.

The default parameters of EIGRP were modified on the S0/0, S0/1, and S0/2 interfaces, as shown in *Fig.* 12. The Hello interval was decreased to three times its original amount, which is 1.6 seconds. The CISCO IOS (c3745) only allows integer values, thus any non-integer values are automatically rounded up to the next whole number, which in this case is two seconds. The Hold Uptime is consistently three times the Hello interval. However, it was adjusted to six seconds due to the Hello interval being two seconds. The neighbors with IP addresses 192.168.35.13, 192.168.34.9, and 192.168.32.4 have Hold Uptime values of 5, 4, and 5 seconds. The 192.168.35.13 neighbor will be considered inactive in one second if the S0/2 interface of the WORKS router does not receive a greeting packet from the S0/0 interface of the ICT router.

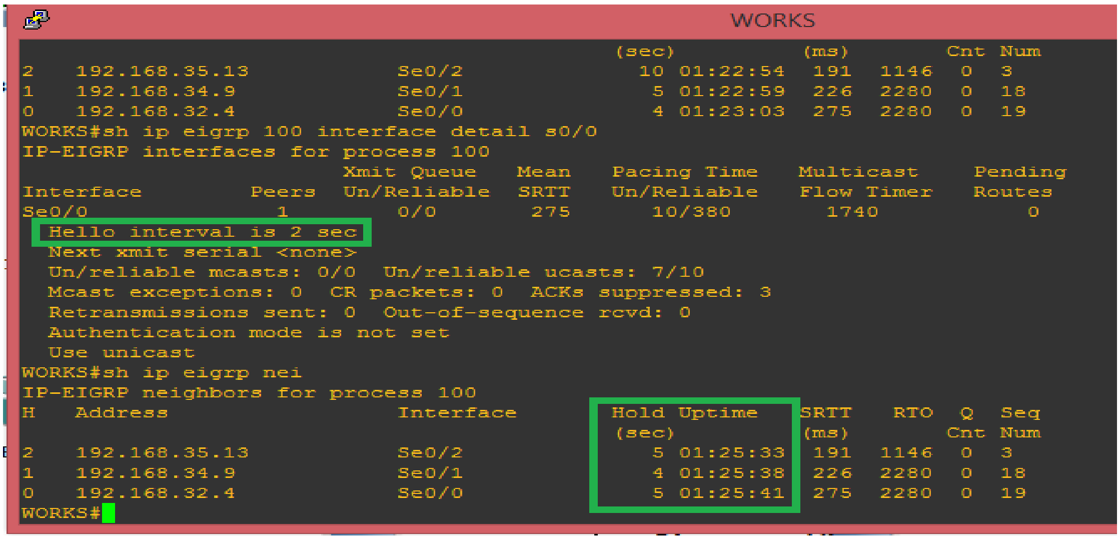


Fig. 12. Modified EIGRP timers.

3 | Results and Discussion

The primary goal of this section is to provide the outcomes and analysis of the processes and techniques outlined in the preceding results, specifically addressing the routing of OSPF via EIGRP using a network simulator. The main objective of this study is to enhance network performance by minimizing the time it takes for the network to converge and reduce the number of loss packets. The objective of this study is to reduce inefficient routing in the process of redistributing routes. A section of the study compares the impact of default settings and adjusted timings on packet losses and convergence time. Another section of the study demonstrates the impact of inefficient routing on network performance.

3.1 | EIGRP_OSPF with Default Timers

Fig. 13 is a pictorial description of the topology used for this simulation. The topology has both OSPF and EIGRP domains. It describes how the loopback address of the Administration (192.168.40.1) could be reached from the ICT department via the paths 192.168.35.12, 192.168.34.9 and 192.168.24.3 using the default timers setting. The serial 0/0 interface of the Administration was shut down while receiving 300 packets from ICT. The link rediscovery time (time taken to find an alternative path), and packets loss after shutdown was analysed. *Fig. 14* represents the ICMP from ICT to Administration in default timers while the result of EIGRP_OSPF ICMP in default settings is presented in *Table 3*. *Fig. 15* shows simulated profile of

the ICMP from ICT to Administration in Modified Timers and the result of EIGRP_OSPF ICMP in modified settings is presented in *Table 4*.

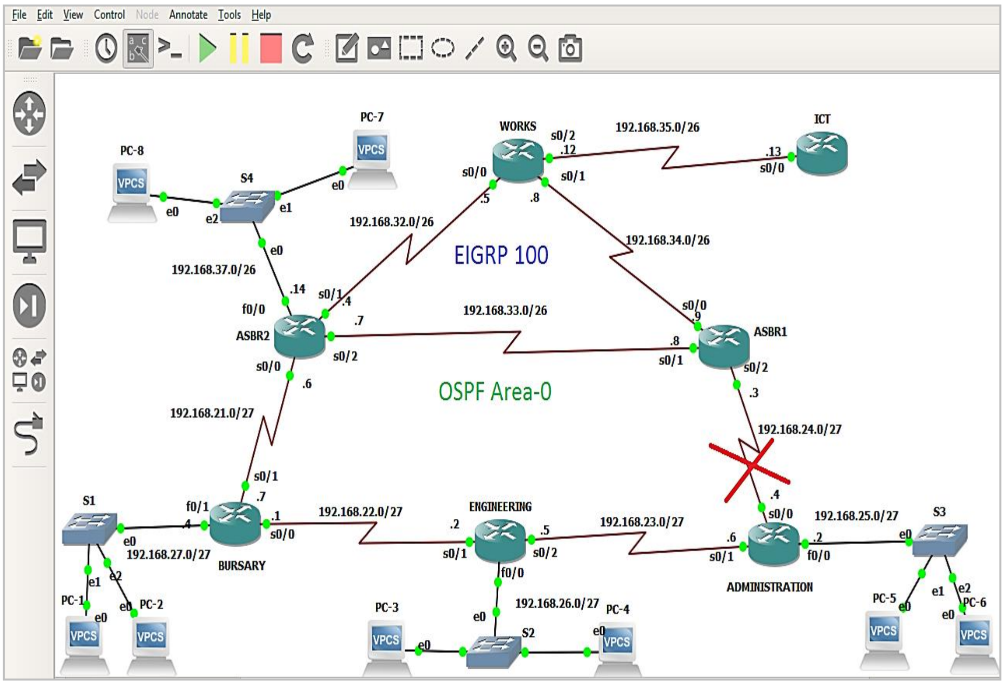


Fig. 13. Shutdown interface of Administration.

Table 3. Results of EIGRP_OSPF ICMP in default settings.

Scenario	Link Rediscovery Time (sec)	Packet Delivered (bytes)	Packet Loss (bytes)
1	29.96	285	15
2	27.49	287	13
3	32.58	286	14
4	30.01	285	15
5	31.22	284	16
6	27.18	287	13
7	24.15	288	12
8	26.25	287	13
9	32.33	283	17
10	24.65	287	13
Average	28.58	285.9	14.1

Table 4. Results of EIGRP_OSPF ICMP in modified setting.

Scenario	Link Discovery Time (sec)	Packet Delivered (bytes)	Packet Loss (bytes)
1	15.89	292	8
2	15.96	292	8
3	16.48	291	9
4	16.14	292	8
5	15.36	292	8
6	17.99	291	9
7	16.12	292	8
8	16.08	292	8
9	17.66	291	9
10	16.40	292	8
Average	16.41	292	8

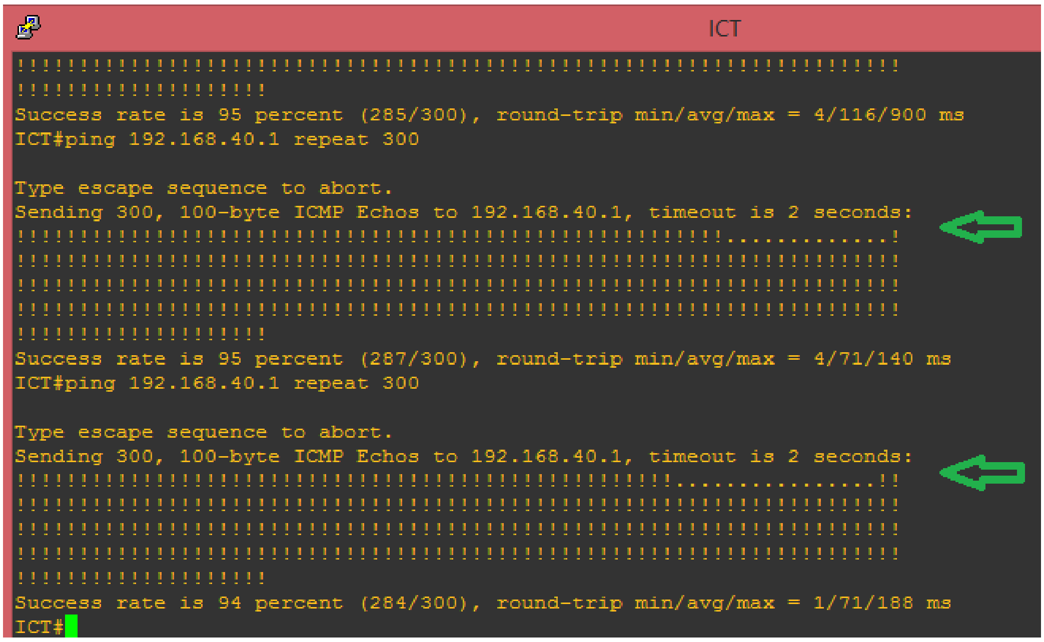


Fig. 14. ICMP from ICT to Administration in default timers.

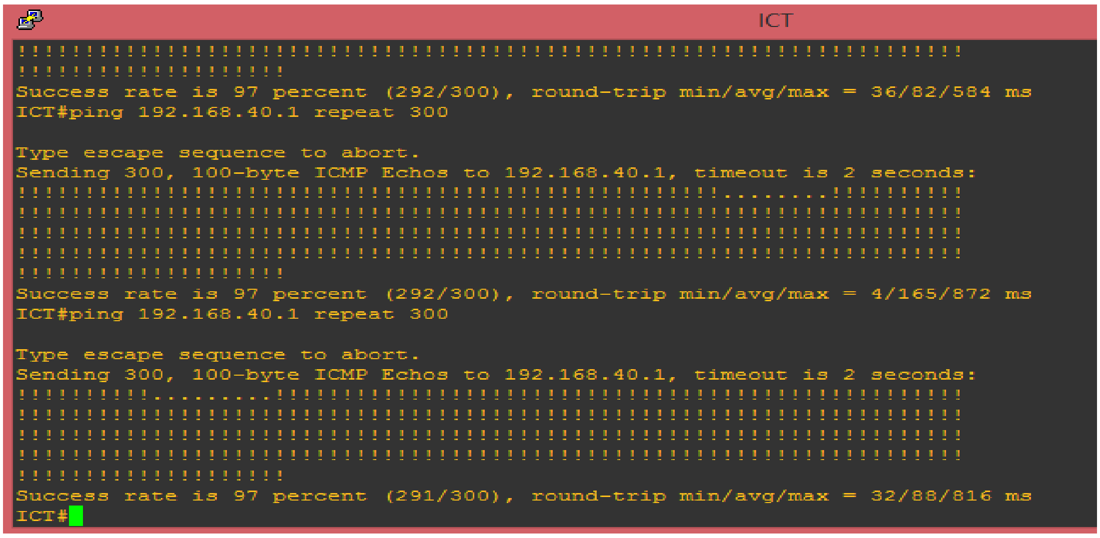


Fig. 15. ICMP from ICT to Administration in modified timers.

3.2 | Anaysis of EIGRP_OSPF Results

From the Output in *Fig. 16*, using the default timers, packets sent from the EIGRP domain (ICT) to the OSPF domain before the interface s0/0 of the Administration was shutdown with 300 bytes. It shows that the interface S0/0 of the Administration started receiving packets before it was shutdown. The link rediscovery time was within a range of 24.15 to 32.58 seconds, and the packets loss were within a range of 12 to 17 packets. From the plot in *Fig.16*, it takes 32.58 seconds to converge, with packet losses of 14 but another scenario indicates that it took 32.33 seconds to converge, with packet losses of 17. This shows the instability in convergence time and packet loss using the default timer settings. From *Fig. 17*, the outputs of the modified timers showed that the convergence time and packet loss after interface S0/0 of Administration was shutdown. The convergence time was within the range of 15.36 to 17.99 seconds, and the packets loss were 8 to 9. During the convergence time of 15.36 to 16.4 seconds, the packets loss were 8, and from 16.4 seconds to 17.99 seconds, the packets loss were 9. From the result in *Fig. 17*, modifying the timers tend to provide stability in convergence time, it then took 15.36 to 17.99 seconds to converge when compared to default

timers which took 24.15 to 32.58 seconds to converge. The packets loss have relatively reduced from 17 to 8 packets, thereby, improving the network performance.

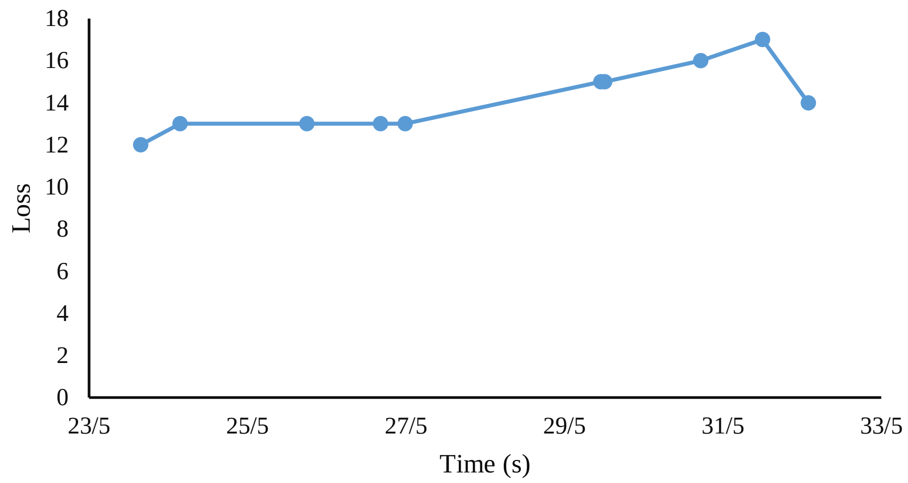


Fig. 16. EIGRP_OSPF default timers.

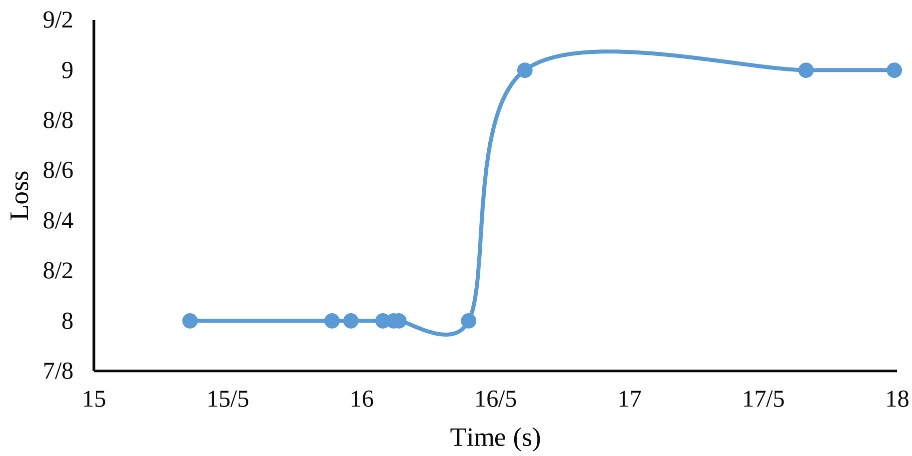


Fig. 17. EIGRP_OSPF modified timers.

3.3 | OSPF_EIGRP with Default Timers

Fig. 18 describes the topology used for the simulation. The topology has both OSPF and EIGRP domains. It describes how the loopback address of the WORKS (192.168.60.1) could be reached from the Administration via the paths: 192.168.35.12, 192.168.34.9 and 192.168.24.3 using default timers. The serial 0/0 interface of WORKS was shut down while receiving 300 packets from Administration. The link rediscovery time (time taken to find an alternative path), and the packet loss after shutdown was analysed. Result of OSPF_EIGRP ICMP in default settings is presented in *Table 5*. However, simulated profile of ICMP from ADMIN to WORKS in modified timers is shown in *Fig. 19* while the Modified Timers in OSPF_EIGRP result is presented in *Table 6*.

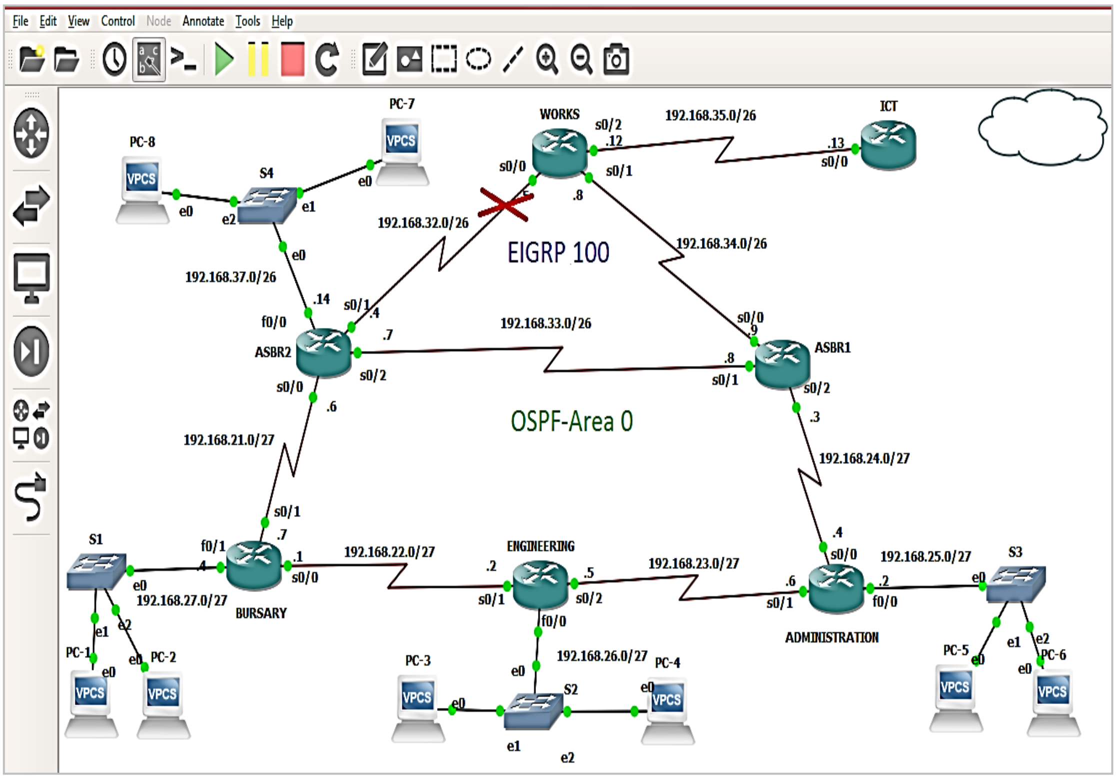


Fig. 18. Shutdown interface of WORKS.

Table 5. Results of OSPF_EIGRP ICMP in default settings.

Scenario	Link Discovery Time (sec)	Packets Delivered (bytes)	Packet Loss (bytes)
1	14.01	293	7
2	12.27	294	6
3	16.13	292	8
4	15.79	292	8
5	15.18	292	8
6	12.59	294	6
7	16.19	292	8
8	16.70	292	8
9	14.25	293	8
10	16.09	292	8
Average	14.92	293	8

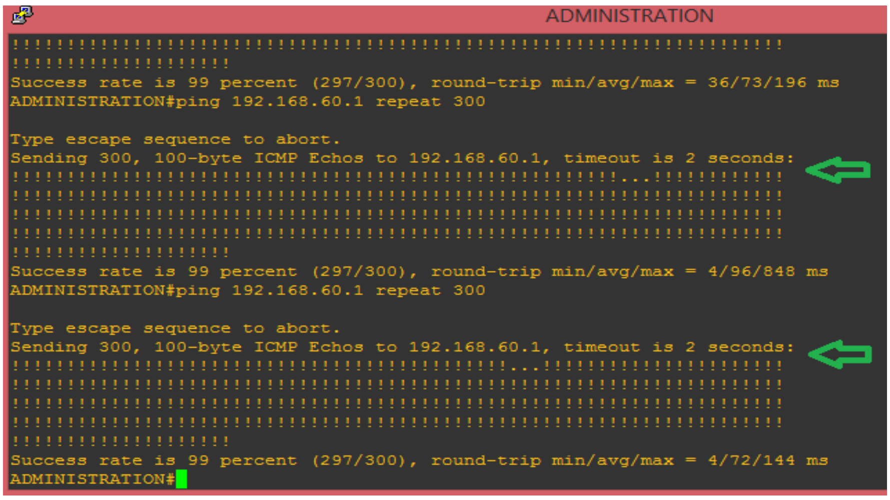


Fig. 19. ICMP from ADMIN to WORKS in modified timers.

Table 6. Results of the modified timers in OSPF_EIGRP.

Scenario	Link Rediscovery Time (sec)	Packet Delivered (bytes)	Packet Loss (bytes)
1	5.79	297	3
2	5.85	297	3
3	6.11	297	3
4	5.94	297	3
5	6.84	96	4
6	6.05	297	3
7	4.87	297	3
8	5.27	297	3
9	6.04	297	3
10	5.94	297	3
Average	5.87	297	3

3.4 | Analysis of OSPF_EIGRP Results

Fig. 20 illustrates the result of packets leaving OSPF domain (Administration) to EIGRP domain (WORKS). This implies that the Works department started receiving packets from Administration before the interface S0/0 was shutdown abruptly. The result showed that the convergence time was within 12.7 to 16.7 seconds, and the packets loss were within the range of 8 to 9.

From *Fig. 21*, the convergence time after links failure was within 4.87 to 6.84 seconds. When compared with *Fig. 20*, the convergence time of the modified timers was faster than the default timers. The convergence time reduced, it is was within the range of 4.87 to 6.84 seconds, thereby, providing stability. The packets loss were within the range of 3 to 4, this reduced when compared to default timers which had a packet loss of 8. These reductions in convergence time and packet loss suggests that the performance of the network has significantly improved.

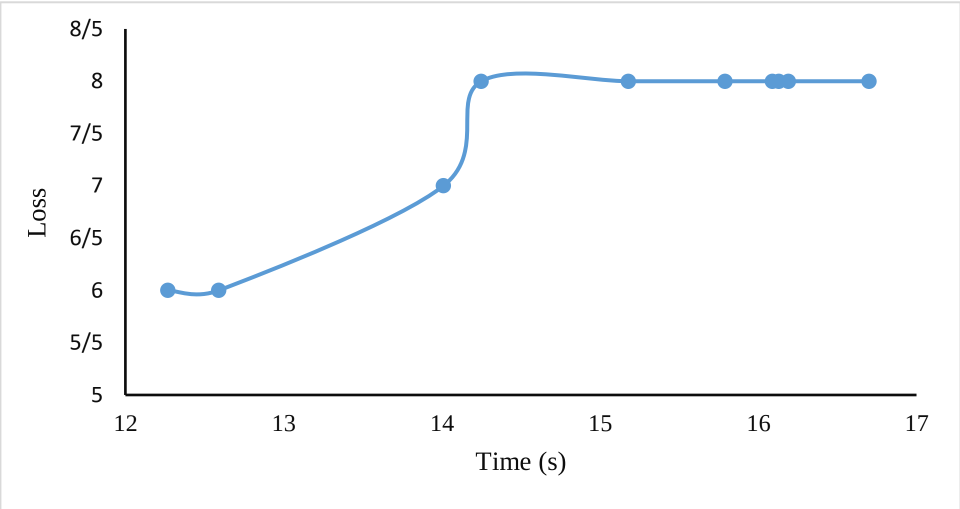


Fig. 20. OSPF_EIGRP default timers.

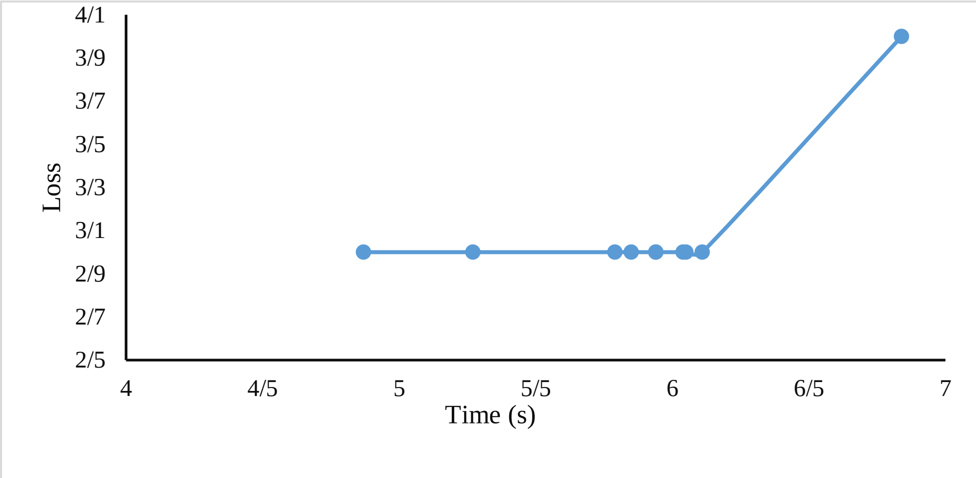


Fig. 21. OSPF_EIGRP modified timers.

3.5 | Analysis of Suboptimal Routing

From *Fig. 22*, the network 192.168.61.1 which is the loopback address of the WORKS department could be reached from BURSARY department via 192.168.22.2. This route was learned as an OSPF external route (O E2). The ASBR1 and ASBR2 are connecting routers in the OSPF domain, and they have exit interfaces of 192.168.24.3 and 192.168.21.6 in the OSPF domain. The BURSARY prefers path 192.168.24.3 because it has the highest router interface amongst the exit interface of the OSPF speaking routers. *Fig. 23* shows the paths and time it would take to reach network 192.168.61.1 from BURSARY. It takes a longer path and time, and this is known as suboptimal routing.

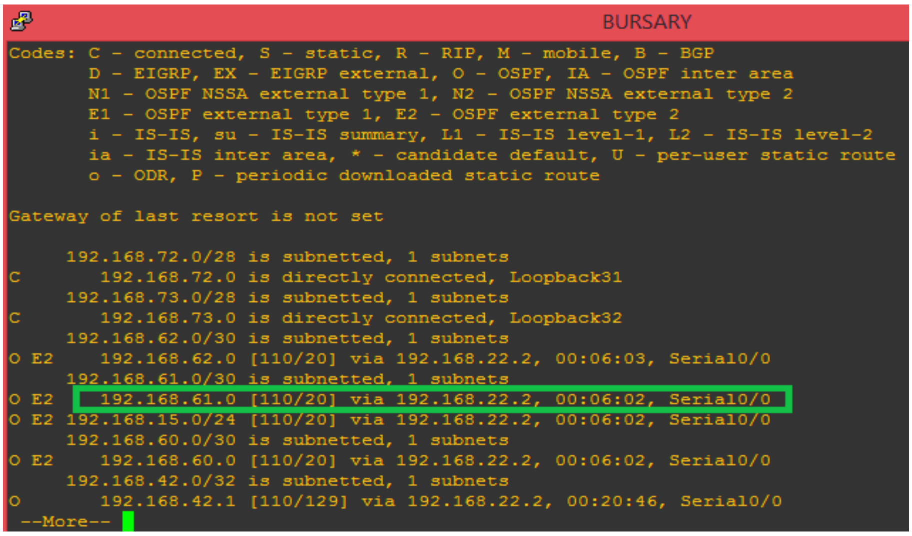


Fig. 22. Bursary receiving updates from 192.168.22.2.

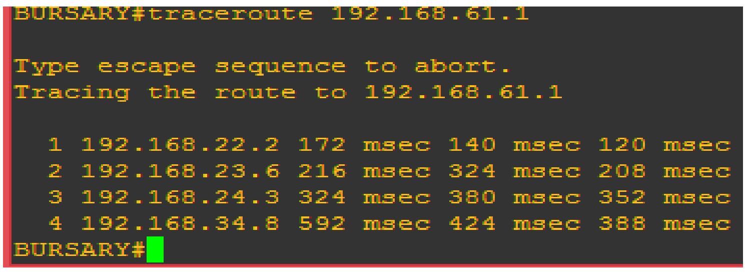


Fig. 23. Numbers of paths taken to 192.168.61.1 from bursary.

From *Fig. 24*, the Administrative Distance (AD) of ASBR1 was reduced from 90 to 85 in the EIGRP domain. Both ASBR1 and ASBR2 had the same AD and Feasible Distance (FD) of 110/20 in the OSPF domain. Since the ASBR1 path was preferred, it was expedient to reduce the AD of the ASBR1 in the EIGRP domain. After the reduction, the ASBR2 was preferred i.e. 192.168.221.6. From *Fig. 25*, a traceroute to 192.168.61.1 showed that two paths are required to reach the network from BURSARY. It took two hop counts and about 30 milliseconds. When *Fig. 23* is juxtaposed with *Fig. 25*, the result is glaring. From *Fig. 23*, it took four hop counts, and about 862 milliseconds to reach the loopback address 192.168.61.1 from BURSARY. From *Fig. 25*, it took two hop counts, and about 30 milliseconds to reach loopback address from BURSARY. The issue of suboptimal routing has been eliminated since packets can be routed from the Bursary to the Works department using few hop counts and shorter time.

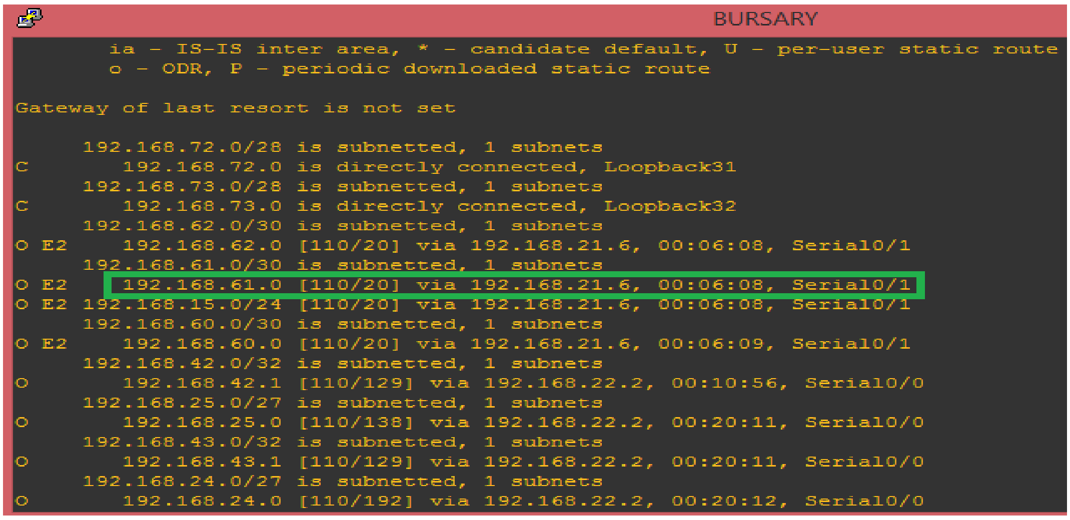


Fig. 24. Bursary receiving updates from 192.168.21.6.

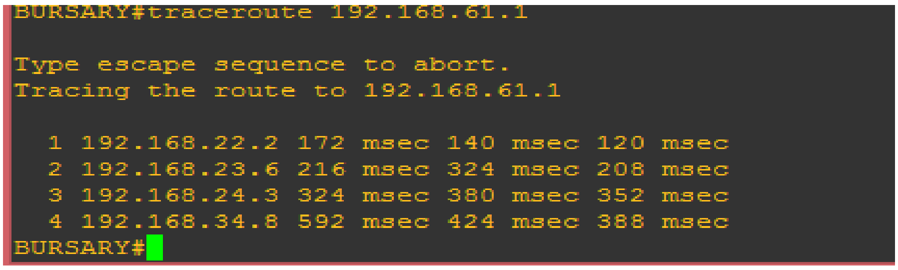


Fig. 25. Paths to 192.168.61.1 from bursary.

4 | Conclusion

From the results obtained, it reveals that significant reductions of the Hello, retransmit, dead and hold-up timers of the OSPF and EIGRP protocols in a route redistributed network improve network performance. Modified timers reduce the convergence time and the packet loss during routing. It improves network stability. The network performance of route redistributed networks could be improved if packets are forwarded through a few hop counts amidst many existing paths, thereby ensuring timely delivery of packets. This study is a template for IT departments running multiple protocols simultaneously. This study has given insights on how to improve the performance of multiple routing protocols running as a single instance. Network engineers and administrators should be thoroughly grounded in route redistribution if they intend to run multiple protocols. The functions of the ISPs should not terminate at the Data Terminal Equipment (DTE) but should be an integral part of the DCE of their respective clients. In future, research work could be carried out on security vulnerabilities in route redistribution using IPv6 environment.

References

[1] Kashif, M., Talib, R., Ayub, N., Umer, M., & Ullah, S. (2017). OSPF vs EIGRP: A comparative analysis of CPU utilization using OPNET. *International journal of advanced computer science and applications*, *8*(7), 468–471. DOI:10.14569/ijacsa.2017.080764

[2] Patel, H. N., & Pandey, R. (2014). Extensive reviews of OSPF and EIGRP routing protocols based on route summarization and route redistribution. *Journal of engineering research and applications www.ijera.com*, *4*(9), 141–144. www.ijera.com

[3] Benson, T., Akella, A., & Maltz, D. (2009). Unraveling the complexity of network management. *Proceedings of the 6th usenix symposium on networked systems design and implementation, nsdi 2009* (pp. 335–348). USENIX Assoc.

[4] Le, F., Xie, G. G., & Zhang, H. (2007). Understanding route redistribution. *Proceedings - international conference on network protocols (ICNP)* (pp. 81–92). IEEE. DOI: 10.1109/ICNP.2007.4375839

[5] Akinola, G. O. (2012). Effect of globalization on performance in the nigerian banking industry. *International journal of research in humanities, arts and literature*, *5*(1), 57–62.

[6] Srivastava, R. (2017). Route redistribution between EIGRP and OSPF routing protocol using GNS3 sofware. *International journal for research in applied science and engineering technology*, *5*(1), 1232–1237. DOI:10.22214/ijraset.2017.11180

[7] Manzoor, A., Hussain, M., & Mehrban, S. (2020). Performance analysis and route optimization: redistribution between EIGRP, OSPF & BGP routing protocols. *Computer standards and interfaces*, *68*, 103391. DOI:10.1016/j.csi.2019.103391

[8] Le, F., Xie, G. G., & Zhang, H. (2010). Theory and new primitives for safely connecting routing protocol instances. *Computer communication review*, *40*(4), 219–230. DOI:10.1145/1851275.1851210

[9] Le, F., Xie, G. G., Pei, D., Wang, J., & Zhang, H. (2008). Shedding light on the glue logic of the internet routing architecture. *Computer communication review*, *38*(4), 39–50. DOI:10.1145/1402946.1402964

[10] Mayr, C., Grampín, E., & Risso, C. (2018). Optimal route reflection topology design. *LANC 2018 - proceedings of the 10th latin american networking conference* (pp. 65–72). Udelar. FI. DOI: 10.1145/3277103.3277124

[11] Devikar, R. N., Patil, D. V., & Chandraprakash, V. (2016). Study of BGP convergence time. *International journal of electrical and computer engineering*, *6*(1), 413–420. DOI:10.11591/ijece.v6i1.8106

[12] Alraddadi, A. (2014). Evaluation of packet loss effect on network performance. *International journal of latest research in science and technology*, *3*(6), 177–182.

[13] Hamza, F. A., & Mohamed, A. M. (2011). Performance comparison of two dynamic routing protocols : RIP and. *Journal of emerging trends in computing and information sciences*, *2*(10), 509–513.

[14] Hinds, A., Atojoko, A., & Ying Zhu, S. (2013). Evaluation of OSPF and EIGRP routing protocols for IPv6. *International journal of future computer and communication*, *2*(4), 287–291. DOI:10.7763/ijfcc.2013.v2.169

[15] A, S., & J.Rana, W. (2013). Performance analysis of RIP and OSPF in network using OPNET. *International of computer science issues (ijcsi)*, *10*(6), 256–265.

[16] Krishnan, Y. N., & Shobha, G. (2013). Performance analysis of ospf and eigrp routing protocols for greener internetworking. *2013 international conference on green high performance computing, icghpc 2013* (pp. 1–4). IEEE. DOI: 10.1109/ICGHPC.2013.6533929

[17] Singh, J., & Mahajan, R. (2013). Simulation based comparative study of RIP, OSPF and EIGRP. *International journal of advanced research in computer science and software engineering*, *3*(8), 2277–128.

[18] Zhao, D., Hu, X., & Wu, C. (2013). A study on the impact of multiple failures on OSPF Convergence. *International journal of hybrid information technology*, *6*(3), 65–74. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.357.9915

[19] Dangi, V. (2014). Comparative performance analysis of link recovery between eigrp and ospf protocols based on simulation. *International journal*, *2*(1), 432–436.

[20] Dangwal, K., & Kumar, V. (2014). Comparative study of eigrp and rip using cisco packet tracer. *International journal of engineering sciences & emerging technologies*, *6*(6), 475–480.

[21] Iqbal, A., & Khan, sameer liaqat ali. (2015). Performance evaluation of real time applications for RIP , OSPF and EIGRP for flapping links using OPNET modeler. *International journal of computer networks and communications security*, *3*(1), 16–26.

[22] Nagendra, M., & Sathyanarayana, R. (2016). Performance optimization of OSPF protokol in IPv6 networks. *International journal of innovative research in computer and communication engineering (IJIRCCE)*, *3*(2), 1-25.